Forecasting Financial Performance of Agricultural Enterprises Based on Supply Chain Operation in Seasonal Decomposition

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***Abstract*— The authors used prospective estimates of revenue and expenses for ordinary activities, obtained on the basis of a multiplicative trend-seasonal model to predict the profit of an agricultural enterprise. The study draws attention to the fact that the classical decomposition of the trend-seasonal model into trend, seasonal and random components is possible and convenient for forecasting the financial performance of an agricultural enterprise that has seasonality in crop and livestock production. The forecast estimates presented in the article confirmed the main hypothesis of the study – in the presence of objective seasonal fluctuations for the agricultural enterprise, there is a tendency of growth in sales revenue while reducing costs for conventional activities. This will be possible due to the uniform production, efficient use of fixed assets, elimination of loss of working time. However, it is necessary to take into account that the agricultural sector depends on climatic conditions, and there is a risk of losses during harvesting, storage of crops – all this leads to additional costs that reduce the profits of the organization. The quality of the obtained predictive estimates is verified by the ratio of the sum of squares of absolute errors and the total sum of squares of deviations of the actual levels of the predicted value. The results of the empirical estimates confirmed the feasibility of practical use of the multiplicative trend-seasonal model, based on the classical decomposition to predict the financial performance of the agricultural enterprise.**

***Keywords*—** *sales revenue, expenses for ordinary activities, forecast, supply chain operation, seasonal decomposition, trend-seasonal model.*

1. Introduction

The analysis of the profit and profitability level makes it possible to identify trends in the development of the enterprise, to indicate to the management the ways of further successful development, to point out mistakes in economic activity, as well as to identify reserves for profit growth, which, ultimately, allows for more successful operation [1;2;3;4-10]. The purpose of the analysis of the financial results of the agricultural enterprise is to provide timely management information that allows you to form an objective opinion about the results of activities for the reporting period compared to the previous year, as well as to identify the factors that led to changes in the indicators of financial results and to develop measures to optimize profits [11-15]. For this reason, the study of financial indicators is essential in the analysis of the agricultural enterprise. The growth of the financial results strengthens the position of the company in the industrial and financial sector, and also stimulates the inflow of investments [15-25]. Thus, one of the tasks is a perspective analysis of the financial results of the agricultural enterprise. There is an analysis of the long-term and medium-term prospects, but in the long term it is impossible to make a detailed and accurate forecast [12]. For this reason, short-term forecasts are often used, as their results are more accurate and reliable [13;14;21-23]. The purpose of this study is to forecast revenue from sales and expenses for ordinary activities as the main indicators that form the profit of an agricultural enterprise for the purchasing management based on the supply chain operation. The main hypothesis of the study – in the presence of objective seasonal fluctuations for the agricultural enterprise, there is a trend of growth in sales revenues while reducing costs for conventional activities [25, 26].

2. Methods

For the purpose of forecasting quarterly data on revenue and expenses on usual types of activity of the agricultural enterprise from 2015 to 2018 are used. The choice of trend and decomposition method,on the basis of which the forecast will be built, should be based on the tasks assigned to the forecaster, as well as taking into account all the advantages and disadvantages of known methods. In this study, we used a multiplicative trend-seasonal model based on the classical decomposition:

$Yt=Tt*St*Et$,

where Tt - time trend of the dynamic series, regular component characterizing the General trend of development;

St- seasonal component, which is characterized by the duration of the period of seasonal fluctuations, their amplitude;
Et - a random component that represents small deviations impossible to predict in the long run.
Construction of the model is reduced to the calculation of the values T, S and E for each level of the series. The method of constructing a multiplicative model includes the following steps:
1. alignment of the initial series by the moving average method;
2. estimation of the seasonal component;
3. analytical alignment of series levels (T*E);
4. calculation of T values using the obtained trend equation;
5. calculation of the levels of the series for the multiplicative model, by multiplying the levels T to the values of the seasonal component for the respective blocks;
6. the calculation of the error in multiplicative model.

3. Results and Discussion

The table of the company's revenue time series indicates the presence of seasonal fluctuations. During the year, revenue increases in 3 and 4 quarters. This is due to the specifics of the organization, as the main revenue falls on the summer-autumn period, when there is a harvest of crop production [27, 28].

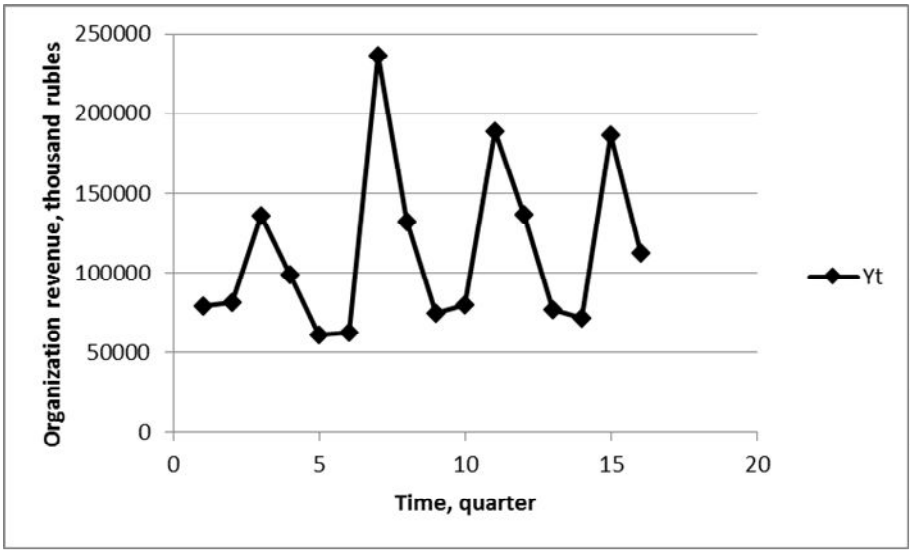

Fig. 1. Dynamics of the company's revenue for 2015-2018

The calculation of seasonal component estimates at the first stage of decomposition is presented in table 1.

Table 1. Calculation of seasonal component estimates in the company's revenue

Period	Revenue	Movingaveragefor 4 quarters	Centeredmovingaverage	Seasonalcomponentassessment
1st quarter 2015	79385			
2nd quarter 2015	81078			
3rd quarter 2015	136087	98861,3	96607,8	1,40866
4th quarter 2015	98895	94354,3	92015,8	1,07476
1st quarter 2016	61357	89677,3	102180	0,60048
2nd quarter 2016	62370	114684	118830	0,52487
3rd quarter 2016	236112	122977	124628	1,89453
4th quarter 2016	132068	126280	128504	1,02774
1st quarter 2017	74568	130728	124831	0,59735
2nd quarter 2017	80163	118934	119546	0,67056
3rd quarter 2017	188937	120158	120437	1,56877
4th quarter 2017	136962	120716	119669	1,1445
1st quarter 2018	76802	118623	118302	0,6492
2nd quarter 2018	71789	117981	114921	0,62468
3rd quarter 2018	186371	111862		
4th quarter 2018	112484			

Source: completed by the author

At the next stage, we will adjust the assessment of the seasonal component. The correction factor will be: K = 4/3,9287=1.01815 (the last line of table 2).

Table 2. Calculation of average seasonal component estimates

Year	№ of the quarter				Sum
	1	2	3	4	
2015	-	-	1,4086551	1,074762	
2016	0,600477342	0,524867	1,89453223	1,027738	
2017	0,597352218	0,670563	1,56876535	1,144505	
2018	0,649204259	0,62468	-	-	
Total for n-th quarter	1,847033819	1,82011	4,87195268	3,247004	
Average seasonal component estimate for that quarter, Sn cp	0,61567794	0,606703	1,62398423	1,082335	3,9287
Adjusted estimate of the seasonal component, Sn	0,626851545	0,617714	1,65345704	1,101977	4

Source: completed by the author

To identify the trend component at the next stage of decomposition, we use the linear trend formula [15]:

Yt = a0 + a1*t,

whereYt –revenue valuesaligned on a linear trend;
a0 – free term; a1–coefficient of the trend equation;
t – the quarter number.

To calculate the coefficients of the trend component, we use the usual method of least squares [16-20] andMS Excel:

T= 111142+396,9209*t

Using the obtained equation, we determine the predicted values of revenue (T t*St) , model errors (table. 3) and present them graphically (Fig. 2).

Table 3. Calculation of the company's revenue after decomposition

Period	Yt	St	Tt*Et=Yt/St	Tt	Tt*St	Yt/ (Tt*S)	Yt- (Tt*St)	$(Et)^2$
1	79385	0,626852	126640,83	111538,88	69918,31	1,14	9466,68	89618049
2	81078	0,617714	131254,88	111935,80	69144,32	1,17	11933,67	142412570
3	136087	1,653457	82304,52	112332,72	185737,32	0,73	-49650,33	2465155158
4	98895	1,101977	89743,22	112729,64	124225,50	0,80	-25330,51	641634496
5	61357	0,626852	97881,22	113126,56	70913,56	0,87	-9556,56	91327858,3
6	62370	0,617714	100969,03	113523,48	70125,06	0,89	-7755,06	60140969,5
7	236112	1,653457	142798,99	113920,40	188362,49	1,25	47749,50	2280015159
8	132068	1,101977	119846,31	114317,32	125975,09	1,05	6092,90	37123471,2
9	74568	0,626852	118956,39	114714,24	71908,80	1,04	2659,20	7071328,61
10	80163	0,617714	129773,62	115111,16	71105,79	1,13	9057,20	82032951,9
11	188937	1,653457	114267,86	115508,08	190987,66	0,99	-2050,66	4205216,98
12	136962	1,101977	124287,49	115905,01	127724,68	1,07	9237,31	85327931,8
13	76802	0,626852	122520,23	116301,93	72904,04	1,05	3897,95	15194053,1
14	71789	0,617714	116217,18	116698,85	72086,53	1,00	-297,53	88524,2586
15	186371	1,653457	112715,92	117095,77	193612,82	0,96	-7241,83	52444093,3
16	112484	1,101977	102074,69	117492,69	129474,27	0,87	-16990,28	288669597

Source: completed by the author

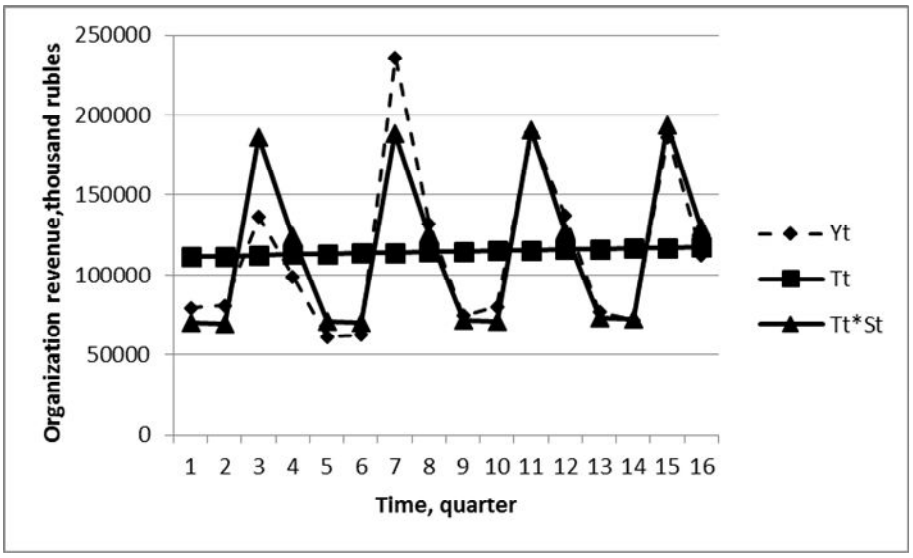

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Fig. 2. Actual and post-forecast values of the company's revenue

In the multiplicative trend-seasonal model of the company's revenue, the sum of the squares of absolute errors is 6342461426. Total sum of squares of the deviations of actual levels of revenue from the average value equal 40916148199. Thus, the proportion of explained variance of time series levels of revenue equal to: (1-6342461426/40916148199)=0,845, or 84.5% of what he says about the high quality of the fit of the model to actual data on revenue.

Using the seasonal component and trend values from 17 to 28 quarter of 2019-2021, we find the forecast data for the next 4 years (Table4). Forecast values do not contain a random component of Et.

Table 4. Forecast sales to 2019-2021 years.

Period	St	Tt	Tt* St
1 quarter 2019 г.	0,626852	117889,615	73899,287
2 quarter 2019 г.	0,617714	118286,536	73067,265
3 quarter 2019 г.	1,653457	118683,456	196237,996
4 quarter 2019 г.	1,101977	119080,377	131223,871
1 quarter 2020 г.	0,626852	119477,298	74894,529
2 quarter 2020 г.	0,617714	119874,219	74047,9996
3 quarter 2020 г.	1,653457	120271,14	198863,163
4 quarter2020 г.	1,101977	120668,061	132973,462
1 quarter 2021 г.	0,626852	121064,982	75889,771
2 quarter 2021 г.	0,617714	121461,903	75028,7343
3 quarter 2021 г.	1,653457	121858,824	201488,33
4 quarter 2021 г.	1,101977	122255,745	134723,054

Source: completed by the author

Table 4 shows that the lowest revenue is expected in the first quarter of 2019, and the highest revenue is expected in the third quarter of 2021.

Schedule of time series of expenses for ordinary activities (Fig. 3) indicates the presence of seasonal fluctuations.

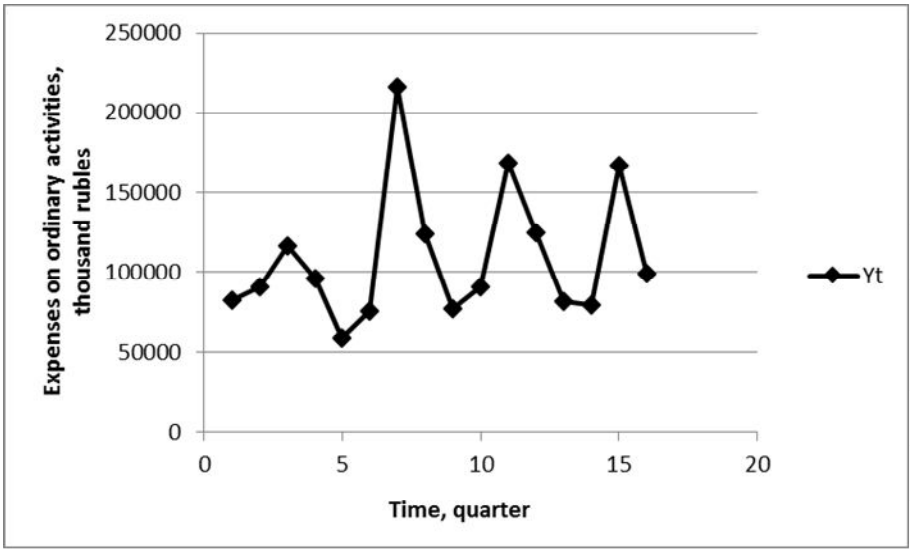

Fig. 3. Dynamics of expenses on ordinary activities of the enterprise for 2015-2018

Different amplitude of seasonal fluctuations led to the choice of a multiplicative trend-seasonal model for forecasting costs for conventional activities (Table 5). Forecast analysis of expenses by usual kinds of activity are presented in Tables 5,6 and in Fig.4.

Table 5. Calculation of costs for ordinary activities of the enterprise after decomposition

Period	Yt	St	Tt*Et= Yt/St	Tt	Tt*St	Yt/(Tt*S)	Yt-(Tt*St)	$(Et)^2$
1	82518	0,66387	124298	107931,31	71652,56	1,15	10865,44	118057774
2	90324	0,73503	122884	108173,90	79511,86	1,14	10812,14	116902350,9
3	115878	1,52588	75942	108416,49	165430,53	0,70	-49552,53	2455453461
4	95929	1,07521	89219	108659,08	116831,44	0,82	-20902,45	436912255,7
5	58889	0,66387	88705	108901,67	72296,75	0,81	-13407,76	179767923,4
6	75146	0,73503	102234	109144,26	80225,11	0,94	-5079,11	25797386,1
7	215738	1,52588	141386	109386,85	166911,18	1,29	48826,81	2384057674
8	123540	1,07521	114898	109629,44	117874,78	1,05	5665,21	32094612,32
9	76590	0,66387	115369	109872,03	72940,95	1,05	3649,05	13315554,1
10	90630	0,73503	123300	110114,62	80938,36	1,12	9691,64	93927798,48
11	168095	1,52588	110163	110357,21	168391,84	1,00	-296,84	88114,89071
12	124571	1,07521	115857	110599,80	118918,13	1,05	5652,87	31954911,79
13	81751	0,66387	123143	110842,39	73585,14	1,11	8165,85	66681152,92
14	78869	0,7350	107299	111084,98	81651,61	0,97	-2782,62	7742953,425
15	167065	1,52588	109488	111327,57	169872,49	0,98	-2807,50	7882034,451
16	98734	1,07521	91828	111570,16	119961,47	0,82	-21227,48	450605718,6

Source: completed by the author

Table 6. Forecast of expenses for ordinary activities of the enterprise for 2019-2021

Period	St	Tt	St*Tt
1 quarter 2019 r.	0,663871851	111812,758	74229,3427
2 quarter 2019 r.	0,735037365	112055,348	82364,8681
3 quarter 2019 r.	1,52587975	112297,939	171353,151
4 quarter 2019 r.	1,075211034	112540,529	121004,819
1 quarter 2020 r.	0,663871851	112783,119	74873,5382
2 quarter 2020 r.	0,735037365	113025,71	83078,1199
3 quarter 2020 r.	1,52587975	113268,3	172833,805
4 quarter 2020 r.	1,075211034	113510,89	122048,162
1 quarter 2021 r.	0,663871851	113753,481	75517,7337
2 quarter 2021 r.	0,735037365	113996,071	83791,3716
3 quarter 2021 r.	1,52587975	114238,661	174314,46
4 quarter 2021 r.	1,075211034	114481,252	123091,505

Source: completed by the author

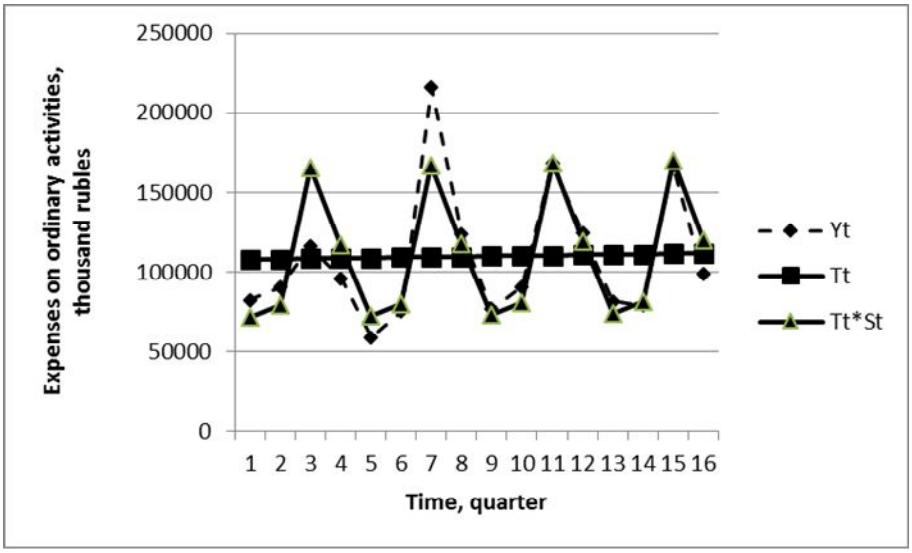

Fig. 4. Actual and post-forecast values of expenses for ordinary activities of the enterprise

In multiplicative trend seasonal model expenses on ordinary types of activities sum of squares absolute error is 6421241677. Total sum of squares of the deviations of actual levels of expenses on ordinary types of activities from the average value equal 216933931315. Thus, the share of the explained variance of the time series levels of expenditures for ordinary activities is: (1-6421241677/216933931315)=0.9704 or 97.04%, which also indicates the high quality of the "fitting" of the model to the actual expenditures for ordinary activities.

In accordance with the forecast values performed using the multiplicative time series model, the lowest amount of expenses for ordinary activities is expected in the first quarter of 2019 – 74229,4535 thousand rubles, the highest amount of expenses – in the 3rd quarter of 2021 (174314,83 thousand rubles).

Using the forecast of revenue and expenses for ordinary activities, we will make a forecast of financial results of the enterprise for 2019-2021.

Table 5. Forecast of financial results for ordinary activities of the enterprise for 2019-2021

Period	Revenue, thousandrubles	Expenses for ordinary activities, thousand rubles	Sales profit, thousand rubles
1st quarter 2019	73899,287	74229,4535	-330,166529
2nd quarter 2019	73067,265	82364,9375	-9297,67252
3rd quarter 2019	196237,996	171353,42	24884,57593
4th quarter 2019	131223,871	121004,994	10218,87705
Totalfor 2019	474428,419	448952,805	25475,61392
1st quarterof 2020	74894,529	74873,671	20,85798988
2nd quarterof 2020	74047,9996	83078,2131	-9030,21342
3 quarter 2020	198863,163	172834,125	26029,0378
4th quarterof 2020	132973,462	122048,372	10925,09003

Totalfor 2020	480779,154	452834,382	27944,7724
1st quarterof 2021	75889,771	75517,8885	371,8825093
2nd quarterof 2021	75028,7343	83791,4886	-8762,75431
3rd quarterof 2021	201488,33	174314,83	27173,49967
4th quarterof 2021	134723,054	123091,751	11631,30301
Totalfor 2021	487129,889	456715,958	30413,93088

Source: completed by the author

4. Summary

On the basis of the forecast of financial results of the agricultural enterprise it is possible to draw the following conclusions:
- there is a steady trend of growth in profits from sales, with the amplitude of fluctuations in the values of the projected indicator reaches its maximum value in every 3 quarter of the analyzed period. This is due to the seasonality of crop production sales.
- the greatest impact on the profit from sales will have an increase in sales and increase in sales prices.

It should be taken into account that the agricultural sector depends on climatic conditions, and there is a risk of losses during harvesting, storage of crops – all this leads to additional costs that reduce the profits of the organization. Therefore, the company should pay attention to reducing costs, as well as increasing the quality of fertilizers, seeds and feed.

5. Conclusions

The financial results of the agricultural enterprise determine the profit that meets the needs of the organization, or a loss from economic activity. Information on financial results is needed to assess potential changes in resources. Since the company produces and sells crop and livestock products, it is necessary to take into account the seasonal nature of this activity. Natural and climatic conditions that directly affect revenue and, subsequently, the profit of the organization, can lead to a reduction in the yield. The forecast estimates of income, expenses and profit from sales of the enterprise received in research confirm the hypothesis of steady growth of profit from sales. This will be possible due to the uniform production, efficient use of fixed assets, elimination of loss of working time.

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